QUARTERLY REPORT 2/18/1992

# INVESTIGATION TO IDENTIFY AND QUANTIFY MECHANISMS CAUSING REDUCTION OF SALT THICKNESS OF THE BONNEVILLE SALT FLATS, WESTERN UTAH

## Problem:

The thickness of the salt crust, which forms the surface of the Bonneville Salt Flats and covers an area of about 60 square miles, decreased from 1960 to 1988. The decrease is of concern to the U.S. Bureau of Land Management because management plans have designated the Bonneville Salt Flats as an Area of Critical Environmental Concern (ACEC) that should be preserved for future generations.

The exact cause or causes for the decrease in salt-crust thickness and their relative effects are not presently known, although previous investigations have identified possible causes. These possible causes could be related to (1) climatic and/or land-surface fluctuations that create long-term "natural" changes in the hydrologic and hydrochemical system, (2) human interferance that results in changes in the hydrologic and hydrochemical system, or (3) a combination of the two.

## Objectives:

The main purpose of this investigation will be to conceptualize and quantify, where feasible, the natural processes and human activities that cause the transport of salt away from the Bonneville Salt Flats. The salt may be moved while in solution or in crystalline form by several different mechanisms. None can be quantified precisely becuse of cost and time constraints. However, using accepted data-collection techniques and data analysis, acceptable and reproducible estimates of the quantity of salt transported can be made.

To achieve this objective, the study will comprise three elements, (1) transport of salt in solution away from the Salt Flats by wind-driven surface ponds, (2) transport of salt in solution through the unsaturated zone and then by movement in solution through the shallow-brine aquifer away from the Salt Flats to some point of discharge, and (3) estimating the natural salt balance in Pilot Valley, a relatively undeveloped hydrologic system, to use as a base line to approximate what natural salt-transport mechanisms were in effect in the Bonneville Salt Flats area prior to human activities.

2-18-92 Meeting

I. Progress:

The second phase of drilling deep observation wells was completed by the middle of November. This phase included three boreholes located in close proximity to the production well. Each of these boreholes has a single screened interval at a different depth above the production zone. The deepest borehole was cored and two samples were collected for geotechnical analysis. More samples were to be collected. Because of the inadequate drive shoe on the sampler, minimal cores of suitable quality were obtained. Depths for these wells are 122, 194, and 219 feet.

40% recovery if more core needed - do in conj. w/ AFB drilling (March-April)

w/in 500 ft of well to be used for aquifer tests

screened 10' above depth

this 5000 in these states wells

this was done in January

Mass water-level measurements were planned for last November, but extensive surface water prohibited travel on the Bonneville Salt Flats and surrounding carbonate muds.

The first weather station has been installed on the alluvial fan adjacent to the salt crust.

II. Plans for next six months:

Develop all deep wells by producing water and secure with locking caps on surface casing.

Measure brine density and water levels in shallow wells at first time surface conditions permit. These measurements will be used to construct a potentiometric surface for the shallow-brine aquifer.

Begin study of pond migration. The first aerial-photography survey will take place within the next two weeks. Samples from surface ponds will be collected at the same time.

B/W IR photography BLM getting satellite data (current/past)

Conduct aquifer test using the unused production well and monitor water levels in newly completed observation wells. The proposed test would last at least 72 hours with a pumping rate, if possible, of more than 1,000 gallons per minute.

If cores collected during November prove to be inadequate for geotechnical analysis, additional cores may be obtained this spring utilizing Roger Nichols' drilling crew while they are in Utah for Hill AFB drilling.

Drill shallow wells in Pilot Valley and collect water-level and brine density data.

Drill additional shallow wells in the vicinity of I-80 and conduct an aquifer test to determine flow properties of sediments beneath the highway.

With sufficient preliminary data, begin modeling phase of study.

Alluvial-fan aquifer test:

An aquifer test will take place, probably in the beginning of April, that should determine boundary conditions and aquifer properties on the west side of the Bonneville Salt Flats. The four multiple-completion wells in line with the production well and three single-completion wells in close proximity to the production well will be used during the test. However, in the multiple-completion wells, only the two deepest completions will be measured. The location of the production well and the multiple-completion wells are shown in figure 1.

Data from recent drilling indicates that the conceptual model shown in figure 2 is the most probable for boundary conditions on the west side of the Bonneville Salt Flats. This is a slight modification of model #2 shown in the USGS project proposal (fig. 3).

no specific proposals on modeling at this time.

Other than determining aquifer properties of the production zone, data from the multiple-completion well located between the production well and the Silver Island Mountains should provide some insight as to the upgradient boundary conditions for the alluvial-fan aquifer. By using analytical methods that are applicable to leaky confined aquifers in which the storage of water in the confining beds is taken into account, aquifer properties of the confining beds can be determined. Discussion of of flow in leaky aquifers can be found in Neuman and Witherspoon (1969a, b), and Lohman (1972, p. 30-34). Methods developed to analyze leaky confined aquifers with the release of water from storage in the confining bed include "Hantush Modified Method" described by Lohman (1972, p. 32), and the "Ratio Method" described by Neuman and Witherspoon (1972, p 1284). The Hantush method is used to obtain an estimate of transmissivity and storage for the confined aquifer and both methods are used together to obtain an estimate of vertical hydraulic conductivity and specific storage of the confining bed.

Prior to the aquifer test, a radial-flow computer model will be used to simulate probable aquifer properties in order to estimate water-level changes in the observation wells. This procedure will provide insight for revising, if necessary, measurement time intervals and length of time for pumping.

Proposed aquifer-test procedure:

Water levels in all observation wells and the production well will be measured for at least six days prior to the test (twice the pumping time). This will determine any pre-pumping trends from which corrections in drawdown can be made if necessary.

Barometric pressure will be measured prior to and during the test. Measurements will be made either at the weather station installed just north of the production well or at the test site. From these data, corrections for barometric pressure can be made if water-level changes are shown to be affected.

During the test, the production well will be pumped at a constant rate for 72 hours. Depending on yield, the pumping rate should be in the range of 1,000 to 1,500 gallons per minute. The rate of discharge will be monitored during the test. Pumped water will be diverted through a 500-foot discharge line toward the north away from the production well.

Water levels in the production well and all observation wells completed in the production zone will be measured at t=1, 1.2, 1.5, 2, 2.5, 3, 4, 5, 6, 7, and 8 minutes, approximately and at all succeeding mutiples of 10 for thse numbers to the end of pumping. Where feasible, pressure transducers and data-loggers will be. This same procedure will be followed when the pump is turned off. Water levels in the observation wells completed in the confining bed do not have to be measured at the same frequency. For the ratio method, water-level measurements in the confining bed need only coincide in time with measurements in the production zone.

Tim Mason
Jeff Freethey

References Cited

Lohman, S. W., 1972, Ground-water hydraulics: U.S. Geological Survey Professional Paper 708, 70 p.

Neuman, S. P., and Witherspoon, P. A., 1969a, Theory of flow in a confined two-aquifer system: Water Resources Research, v. 5, no. 4, p. 803-816.

_____ 1969b, Applicability of current theories of flow in leaky aquifers: Water Resources Research, v. 5, no. 4, p. 817-829.

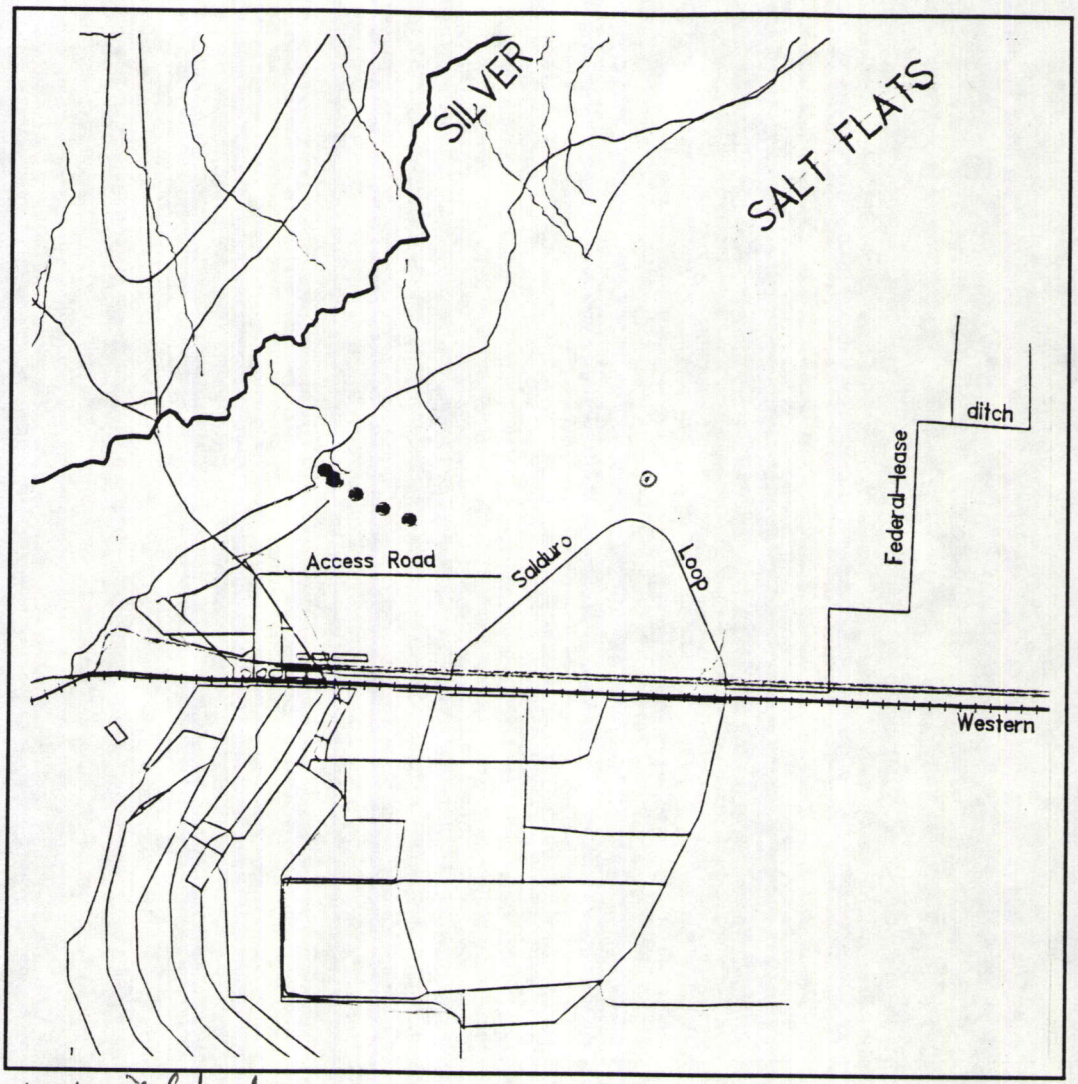
_____ 1972, Field determination of hydraulic properties of leaky multiple aquifer systems: Water Resources Research, v. 8, no. 5, p. 1284-1298.

USGS

- Very little factual information in this report
  - we need to see this
  - if work isn't done, what is the schedule
- Also need technical info on work for next ~~two~~ quarter
- USGS release data w/o interpretation from SLC
  - interpretive reviews need approval from CA & DC
  - ~~Committee~~ commit to do this.
- what is study plan for pond migration?

BLM

- Interagency agreement
- status of Salt Replacement studies - when will ~~if~~ it be released? Cotthorp hasn't seen it.




Detail of drill holes

N

Road

7200

194

219

7200

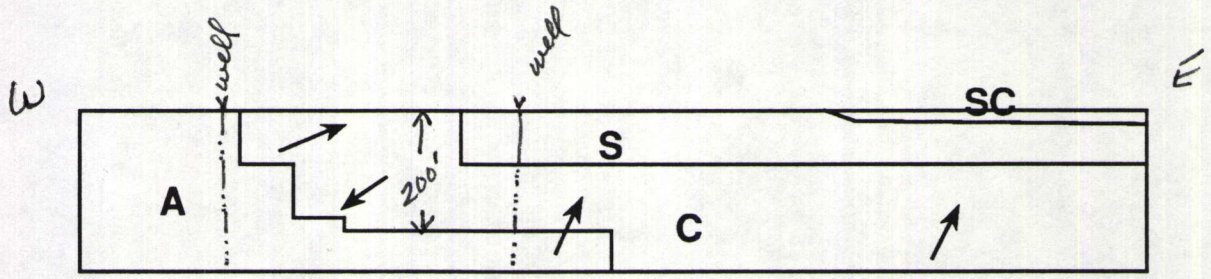
7200

7200

122

Figure 1.--Location of production and observation wells.

plus one well in center & track — 3 completions/well bore




**EXPLANATION**

A = BRACKISH ALLUVIAL FAN AQUIFER

C = SEMI-CONFINING LACUSTRINE CLAY AND MUD

S = SHALLOW BRINE AQUIFER

SC = POROUS SALT CAP

V well locations - eastern most and western most

; completion zone

Figure 2.--Probable simple conceptual model of possible fluid and salt migration in the vicinity of the Bonneville Salt Flats.

See prior quarterly report for screen intervals

Tim Masters
George Pepper
Pam ~~Smith~~ Muir
Joe Eaton

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meet at USGS office next time —
to where ~~mapsps~~ data is — mips/loop/etc.

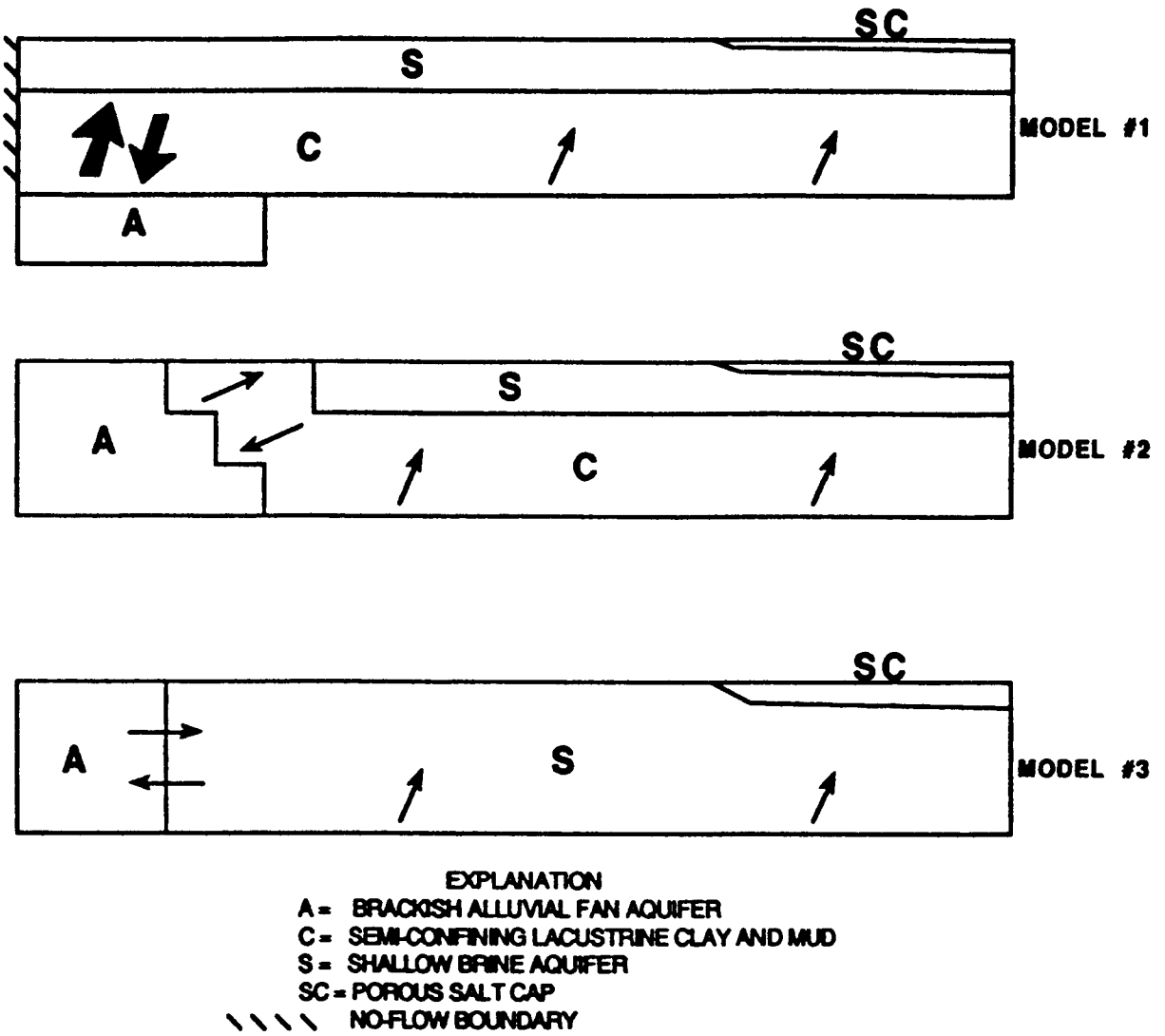


Figure 3.--Three simple conceptual models of possible fluid and salt migration in the vicinity of the Bonneville Salt Flats.

DRAFT MINUTES OF TECHNICAL REVIEW COMMITTEE MEETING 1-24-91
Recorded by C. Forster

Present:

Phil Allard
Paul Anderson, Chair
Hugh Coltharp
Craig Forster, Vice Chair
Jim Kohler
Tom Netelbeek
Stan Plaisier

Location: U.S. BLM offices, Salt Lake City

1. Phil Allard was introduced as the committee's liason with Deane Zeller and the Salt Lake office of the BLM. Phil's responsibilities include:
    - administrative and technical assistance
    - ensure requisitions are processed
    - regular review of USGS activities
    - liason with the office of the State Climatologist (Donal Jensen)
        - weather stations are property of USU
        - 1 station installed in November south of Silver Island

2. Committe members introduced to Phil Allard

3. Review Charter of Technical Review Committee
    Motion: Recommend to BLM that office of secretary/treasurer be eliminated from Charter
    Moved by PA
    Seconded by TN
    Vote: motion carried - unanimous

4. Discussion of role of committee and it's function
    CF - background thoughts on responsibilities of committee
    - now that project is funded, committee needs to be more agressive in reviewing technical work
    - should we have meetings other than those scheduled for U.S.G.S. reports of progress?
    - what avenues are available for the committee to reach meaningful conclusions regarding technical activities?
    - how should views of the committee be transmitted to the U.S.G.S.?
    - if committee is to assimilate and make judgements on progress of technical work we need a greater number of meetings and must develop a plan to ensure that each technical issue raised by the committee is satisfactorily resolved
    JK - purpose of committee is to ensure that the final report is clear and concrete
    - more agressive approach is appropriate
    - U.S.G.S. seems reluctant to release data - Is this a problem?
    PhA - currently writing interagency agreement
    - TRC role is to function as quality control
    - BLM is a co-operator on project therefore TRC falls under BLM for administrative purposes
    - as a consequence, concerns raised by the TRC should be transmitted to the BLM District Manager for subsequent transmission to the USGS District Chief
    TN - USGS indicated plans to produce quarterly reportrs



approved w/ corrections

- members of the TRC should have a copy of the quarterly report in hand before a meeting is scheduled between the TRC and USGS
- TRC should meet separately 1/2 hour before USGS presentation with a separate followup meeting either following the presentation or at a later date

PA - USGS presentations at previous meetings have been difficult to follow because appropriate maps, charts, and tables were lacking
- future presentations need visual aids

WG - uncertain how brine chemistry is being accounted for in work

TN - the committee should learn more at the next review meeting

Motion: In future we should convene TRC 1/2 hour prior to scheduled USGS presentation in order to compare notes of individual committee members regarding previously circulated quarterly report that forms the basis for the presentation. The TRC would continue to meet separately for 1/2 hour following the USGS presentation.
Moved by CF
Seconded by TN
Vote: motion passes - unanimous

PhA - Pumping test for alluvial fan is scheduled for February
- Pumping test for highway median is scheduled for summertime

PA - quarterly reports should report progress and forecast activities for next quarter
- each committee should be able to independantly explore a particular activity, express concerns to committee and request that the committee review the issure of concern

PhA - although committee members should be able to informally interact with USGS, any informal contact should be used to influence the course of the study

JK - quarterly reports should report progress and forecast activities for next quarter

PA - the TRC should formally review and vote on acceptance of minutes of previous meeting in order to ensure that the views of the committee are contained in the written record
- minutes from last meeting have yet to be received, previous minutes have been received
- because recorder of previous meetings is unfamiliar with concepts, records of previous meetings is somewhat unfocussed

PhA - perhaps BLM can provide a better filter to enhance recordkeeping
- he will review current status of records

5. Presentation by and meeting with Deane Zeller (BLM District Chief)

DZ - appreciate assistance of TRC
- priorities
  - need best available specialists working on project
    - USGS
    - review committee
  - BLM is relying heavily on TRC review in order to make decisions on how to mitigate the Salt Flat problem
- Phil A. will fill the committee in on funding situation
  - money is available
- formally/informally need to keep interested parties connected to the project
- reiterate importance of project

TN - note that mitigation methods will not be addressed by USGS

DZ - reviewing budgets to FY '94

TN - should encourage mitigation efforts

6. Election of Officers

PA - elections required annually
- suggest

obtain nominees by volunteering
tie-breaking will be conducted by flipping a coin
3 votes for each member to cast between two positions (chair and vice-chair)

Motion: Retain existing chair and vice-chair
Moved by TN
Seconded by HC
Vote: defeated - 3 in favor, 4 against

Nominees: SP, PA, CF, HC
Recorder: Ph.A.
Ballot Results:

| | |
|---|---|
| 11 Anderson | Chairman for 1992 |
| 7 Forster | Vice-Chair for 1992 |
| 2 Plaisier | |
| 1 Coltharp | |

7. Discussion of USGS Study

TN - understood that the new input of current study would be incorporation of modeling study because
- a limited amount of new data would yield new constraints for modeling studies

CF - unclear if original emphasis on modeling will be carried out
- we need to obtain updated information on level of effort to be applied in modeling study, staffing, and approach to be adopted

PhA - Salt Lake City office of the USGS WRD is now in California region rather than supervised by Denver - this may impact in a positive way in getting modeling organized
- USGS is concerned (as of Nov.) that they may only be able to run 2-D or quasi 3-D models
- as of December, USGS is more confindent that a model developed and applied in the San Jauquin Valley may be used
- under the impression that modeling is central to project
- enthusiasm of USGS staff for project may be low

WG - checks and balances built into USGS structure drags enthusiasm

PA - hopefully committee interest will help buoy enthusiasm of USGS and TRC

PhA - funding additional $683,000 for study
- $50,000 allocated to weather instruments and their maintenance
- $570,000 to WRD for FY '92
- Balance ($20,000) is retained for miscellaneous expenses
  - BLM payroll
    - develop partnerships between future users of salt flats for longterm management
- Unfunded - mineral assessment for air force lands south of highway
- Congress - wants recommendations regarding how to manage the salt flats in the long term
- $570,000 = what was requested for FY '92
- money expended in FY '91 is a bonus with
- Geoff Freethey has hired Bill Brothers ~~for~~ an assistant to help technical assistance

Motion: The committee should request that the USGS present an update on the current status of the planned modeling effort and outline both short and longterm plans for modeling
Moved by CF
Seconded by PA
Vote: passed - unanimous
Action - Ph.A. will transmit request to USGS

SP - modeling requires a good understanding of pre-existing and new data

PhA - previous quarter activities
- 550 foot hole completed with 6 screened intervals
- an effort will be made to establish vertical hydraulic connections and review the boundary conditions associated with the playa margin

PA - what progress has been made in establishing the magnitude of brine flow in ditches?

SP - status is uncertain

PhA - booster pump instrumentation failed

PA - modeling is expected to be an important new contribution of study
- variable density aspect is important

CF - what was outcome of discussion at previous meeting regarding the applicability of performing pumping tests in the highway media?

SP - not certain that pumping test in median is appropriate
- insufficient information has been provided to properly evaluate issue

PA - I believe that the TRC asked the USGS to evaluate existing information and report back to the committee prior to performing a pumping test in the highway median

PhA - are there any questions regarding the pumping test proposed for February?
- any necessary comments should be transmitted to the USGS soon

CF - when is the next quarterly report due?

JK - we are at the end of the 1st quarter now

PhA - written agreement between BLM and USGS is not in place so policy on reporting is still open to final decision
- Freethey is working on '92 plan of work. Although this plan is intended for internal use, it should be available to the TRC

8. Discussion of the Salt Replacement Study

HC - changes in officers of racing organizations has impacted on sponsorship of study caused delays in initiating study
- originally the salt flat coalition included two racing organizations and Reilley
- study funding: 50% Reilly 50% Bonneville Nationals with Utah Salt Flats Racers
- study performed by Bingham (SP was not involved)
- study completed 2 weeks ago
- study should be available in about 2 weeks

PA - what are the expectations of the racers regarding the outcome of the various studies?

HC - probably wonder why the problem can't be fixed tomorrow
- USGS report should outline short term strategy for mitigation
- results of USGS study would be used to structure a partnership between the racing groups, Reilly, and BLM

TN - how substantial is salt replacement effort?

HC - rumor suggests 1st costs are $680,000 with $80-100,000 annually over 10 years
- 0.3 to 0.4 inches of salt might be expected to be deposited per year under "normal" conditions
- large holes in track caused the track to be moved between August and October events
- access road - belongs to county
  - it has been suggested that access road be removed and new access provided directly form I-80
  - county has allocated funds for removing the access road
  - this might occur late spring/early summer '92

PhA - subcommittee of salt flats coalition is evaluating the cost of constructing a new access road
- another alternative is to install culverts to improve surface drainage

JK - is enough known to arrive at conclusion regarding the addition of salt in response to replacement activities?

General - further discussion of salt replacement tabled until study received

9. Other Business

PhA - DZ requested discussion of the mineral resource evaluation planned for Air Force lands south of I-80
- Air Force will permit study to go ahead
- funds are required to clear range of explosives
- BLM will perform the work but need assistance in finding mitigation alternatives that might include alternate sources of minerals
- BLM is looking for both technical and financial assistance
- BLM admits a past adversarial relationship with Reilly, hence is concerned that Reilly lacks confidence in BLM activities

PA - Hill AFB is interested in expanding to the North - this may be a problem
- note that there will be ongoing concerns regarding possible unexploded weapons in reclaimed land

CF/JK- a draft of the minutes of each TRC meeting should be circulated to the committe within 1 to 2 weeks then finalized with any changes indicated by the committee memebers. Minutes should be finalized 2 weeks prior to the next meeting so that a vote can be conducted to mark their acceptance by the committee